

1 CLAIMS

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3 1. A method for improved control of etch or
4 deposition in a semiconductor manufacturing
5 process to produce a structure having a small
6 feature size, the method comprising:

7 providing an illumination source at one or
8 more selected wavelengths;

9 generating from said illumination source
10 an optical probe measurement beam;

11 illuminating an article undergoing
12 processing with said beam, the article having
13 within the area of illumination an ordered
14 feature arrangement having a feature size of
15 the same order as the structure to be produced
16 and being arranged in a regular pattern having
17 a given feature spacing or spacings;

18 said selected wavelength or each of said
19 selected wavelengths being within 30% of a
20 whole number of wavelengths of a size equal to
21 the projection on a plane normal to the
22 illuminating radiation of said feature spacing
23 or a respective one of said feature spacings;

24 detecting an oscillation of a polarisation
25 component in the light beam reflected from the
26 article being processed which is derived
27 substantially from anomalous reflection or
28 Rayleigh Resonance at the feature arrangement
29 resulting from the illumination; and

30 using the oscillation to detect or predict
31 the desired endpoint or monitor the progress in
32 real time of the etch or deposition.

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2 2. The method of claim 1, in which the ordered
3 feature arrangement is a test structure applied
4 to the article for the purpose of monitoring
5 the process.
6
- 7 3. The method of claim 1, in which the ordered
8 feature arrangement comprises structural
9 features of the desired article itself.
10
- 11 4. The method of claim 1, in which the article has
12 an overlying mask which is substantially opaque
13 to the wavelength of the illumination source.
14
- 15 5. The method of claim 1, in which the ordered
16 feature arrangement has a ratio of feature open
17 to etch to features masked from the etch of
18 between 5% and 95%.
19
- 20 6. The method of claim 5 in which the ordered
21 feature arrangement has a simple repeat of the
22 etch structure.
23
- 24 7. The method of claim 5 in which the ordered
25 feature arrangement has no simple repeat of the
26 etch structure.
27
- 28 8. The method of claim 1, in which the probe beam
29 has a linear transverse dimension of 5 μ m or
30 more.
31

- 1 9. The method of claim 1, further including
2 comparing the oscillation information with a
3 model of predicted behaviour.
4
- 5 10. The method of claim 9, in which said model is
6 created by analysing the process critical
7 features, which analysis takes as its input the
8 design of the features and their arrangement
9 with other features in the three dimensions of
10 the overall component together with the optical
11 properties of the materials and the
12 illumination wavelength or wavelengths of the
13 illumination source.
14
- 15 11. The method of claim 10, in which said analysis
16 includes analysis of the behaviour of the
17 illuminating radiation together with its
18 polarisation modes and the interference
19 resulting from the etched (or deposited) film
20 as its thickness varies.
21
- 22 12. The method of claim 11, in which said analysis
23 is used to provide an optimised endpoint
24 approach using the illumination source
25 illuminating an area of an article being
26 processed.
27
- 28
- 29 13. The method of claim 1, including the further
30 step of tuning the illumination means to a
31 selected wavelength.
32

- 1 14. The method of claim 13, in which said selected
2 wavelength is chosen in dependence on the
3 material being examined and remains constant
4 throughout the process.
5
- 6 15. The method of claim 13, in which said selected
7 wavelength is tuned to a number of different
8 wavelengths during the process, and the
9 detected signals are compared with a family of
10 predictions.
11
- 12 16. The method of claim 15 in which the family of
13 predictions includes predictions for feature
14 width as well as depth, and in which the
15 results derived from tuning to different
16 wavelengths are compared with the best fit of
17 a family of predictions to give an estimate of
18 the width of the etch feature.
19
- 20 17. The method of claim 1, in which the spectrally
21 narrow illumination source is provided by
22 combining a spectrally broad source with a
23 wavelength discriminating means.
24
- 25 18. The method of claim 1, in which the
26 illumination source comprises light generated
27 by the deposition or etch process itself.
28
- 29 19. The method of claim 18, in which the deposition
30 or etch process is a plasma process.
31

1 20. Apparatus for use in a semiconductor
2 manufacturing process, the apparatus
3 comprising:
4 a vacuum enclosure;
5 a workpiece location within the enclosure
6 for locating a semiconductor workpiece to be
7 processed to produce a structure having a small
8 feature size, said semiconductor workpiece
9 having an ordered feature arrangement having a
10 feature size of the same order as the structure
11 to be produced and being arranged in a regular
12 pattern having a given feature spacing;
13 an illumination source producing light at
14 one or more wavelengths each within 30% of a
15 whole number of wavelengths of a size equal to
16 the projection upon a plane normal to the
17 incident illumination of said feature spacing;
18 optical projection means cooperating with
19 the light source to produce an optical probe
20 measurement beam directed to said workpiece
21 location;
22 optical detection means arranged to detect
23 an oscillation of a polarisation component in
24 the light beam reflected from the article being
25 processed which is derived substantially from
26 anomalous reflection or Rayleigh Resonance at
27 the feature arrangement resulting from the
28 illumination; and
29 data processing means arranged to use the
30 oscillation to detect or predict the desired
31 endpoint or monitor the progress in real time
32 of the etch or deposition.

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- 2
- 3 21. Apparatus according to claim 20, in which the
- 4 illumination source or the detection means or
- 5 both is provided with polarisation means.
- 6
- 7 22. Apparatus according to claim 21, in which said
- 8 polarisation means is fixed.
- 9
- 10 23. Apparatus according to claim 21, in which said
- 11 polarisation means is rotating.
- 12
- 13 24. Apparatus according to claim 20, in which the
- 14 illumination means is tunable.
- 15
- 16 25. Apparatus according to claim 24, in which the
- 17 illumination source is tuned to a plurality of
- 18 wavelengths during production of a given
- 19 product, and the data processing means is
- 20 arranged to compare the detected signals with a
- 21 family of predictions at said plurality of
- 22 wavelengths.